

THE STRUCTURAL BEHAVIOUR OF CROSS-LAMINATED TIMBER RIB PANELS IN FIRE

Miriam Kleinhenz¹, Alar Just², Andrea Frangi³

ABSTRACT

In the frame of a research project, the structural behaviour in fire and the fire resistance of cross-laminated timber rib panels were studied based on experimental and numerical investigations. The floor system consists of cross-laminated timber plates rigidly bonded to glued-laminated timber ribs. The full composite action between the composite components is provided by means of screw-press gluing. The results of the reference tests showed good agreement with results based on the method of rigidly bonded components and the effective width according to the final European draft of cross-laminated timber design [1]. The fire resistance tests resulted in fire resistances up to 120 min and confirmed the assumption that the effect of the composite action was maintained in fire. In this paper, the numerical investigations cover thermal, and uncoupled thermo-mechanical simulations using a 2D FE model of a linear beam system for discussion of the mechanical behaviour under fire exposure. The numerical results of the tested cross-sections are compared with the experimental results of the fire resistance tests. Depending on the modelled cross-section, the influence of the effective width on the numerical results is investigated.

Keywords: Massive timber rib panel; fire resistance; fire tests; finite element; effective width

1 INTRODUCTION

Long-span floor systems are required for building types such as commercial office buildings, residential buildings, schools, and industrial buildings. As a long-span floor system with spans up to 16 m, cross-laminated timber rib panels consist of cross-laminated timber (CLT) plates connected to glued-laminated timber (glulam) ribs (Figure 1). Full composite action is provided by a rigid connection between the composite components by means of screw-press gluing [2]. For ribbed cross-sections, the assumption that the cross-section remains plane is incorrect. The simple beam theory according to Euler-Bernoulli is not applicable because the strains in the flange vary with the distance from the rib due to the in-plane shear flexibility of the flange. This leads to a non-uniform distribution of the longitudinal strains along the flange width. For simplified structural analysis, the effective width defines an equivalent cross-section that provides the same maximum bending stress and effective bending stiffness as the actual cross-section [3]. The final European draft of CLT design [1] for a revised version of EN 1995-1-1 [4] proposes simplified formulae to estimate the effective width for ribbed plates build up from cross-laminated timber plates. In the case of uniformly distributed loads, equation (1) determines the effective width at normal temperature b_{ef} according to prEN 1995-1-1:20xx [1], as explained in Figure 1

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Wilde, S. Hernandez, S. Kravanja, 2018-12-03 Papers presented at the 2018 International Conference on High Performance
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easily resist a range of external stimuli or react in a non conventional manner Particular emphasis is placed on intelligent
structures and materials as well as the application of computational methods for their modelling control and management

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Structural Behaviour of Timber Construction in Seismic Zones Ario Ceccotti, 1990. *The Structural Behaviour of Curved Glued Laminated Timber Beams* J. A. Anderson, 1976. Structural Rehabilitation of Old Buildings Aníbal Costa, João Miranda Guedes, Humberto Varum, 2013-09-11. This present book describes the different construction systems and structural materials and elements within the main buildings typologies and it analyses the particularities of each of them including at the end general aspects concerning laboratory and in situ testing, numerical modeling, vulnerability assessment and construction maintenance.

Structural Behaviour of Timber Constructions in Seismic Zones, 1990. From Materials to Structures: Advancement through Innovation Bijan Samali, Mario M. Attard, Chongmin Song, 2012-11-26. From Materials to Structures: Advancement through Innovation is a collection of peer reviewed papers presented at the 22nd Australasian Conference on the Mechanics of Structures and Materials (ACMSM22) held in Sydney, Australia from 11-14 December 2012 by academics, researchers and practising engineers mainly from Australasia and the Asia Pacific.

Semi-rigid Timber Joints: Structural Behaviour, Modelling and New Technologies, 1999*. *Advances in Steel and Steel-Concrete Composite Structures* Wojciech Lorenc, Dariusz Czepizak, Piotr Koziol, Marian A. Gizejowski, Jakub Marcinowski, Eugeniusz Hotała, 2025-12-10. Advances in Steel and Steel Concrete Composite Structures: Bridging Science and Industry presents the proceedings of the 15th International Conference on Metal Structures (ICMS 2025) held on May 28-30, 2025 in Wrocław, Poland. The volume reflects the conference theme: Science for Industry and brings together contributions from leading researchers and practitioners in structural engineering. This book gathers peer reviewed papers covering the most recent advances in steel and steel concrete composite structures, emphasizing the interplay between fundamental research and industrial applications. Contributions are organized into thematic sections that reflect the breadth of current developments in the field, from material properties to complex structural systems, stability and buckling of steel members, innovations in composite steel concrete solutions, conservation and adaptation of heritage structures, structural health monitoring and digital innovation, advanced design of connections, steel and composite bridges and thin walled and lightweight structural systems. The volume highlights experimental investigations.

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Structural Behaviour of Timber Concrete Composite Connections and Floors Utilising Screw Connectors Farzad Moshiri,2014 **Computational Study on Structural Behaviour of Timber Concrete Composite Shear Connectors** ,2008 **Timber Structures and Engineering** De Proft, K.,Brebba, C. A.,Connor, J.,2018-02-06 This book contains papers presented at the 1st International Conference on Timber Structures which was held in collaboration with the Technical Centre of Wood Industry in Belgium It explores the latest developments in wood products and their application as structural components The focus of the included works is to draw attention to new research and real applications from both researchers and practitioners and to present new and innovative ideas in this significant field Rapid advances have recently been made in the development and processing of innovative ecologically friendly wood products A variation of new structural shapes can now be fabricated and used to construct buildings and bridges which have minimal impact on the environment Wood is particularly appealing since it is renewable and has no carbon footprint when it is harvested in a sustainable way Timber structures are ecologically sound and comparatively low cost The material lends itself to ground breaking designs and new types of composites offer reliable robust and safe materials The content of this book comprises a range of topics Material properties of wood Durability aspects service life modelling Fire safety of timber structures Protection against decay Non destructive inspection and monitoring Glued laminated structures Xlam and CLT Timber joints and connections Vernacular wood and heritage timber structures Timber housing and eco architecture Timber bridges Large span timber roof structures Shell structures in timber Mixed composite and hybrid structures Computational analysis and experimental methods Structural engineering and design Seismic behaviour of timber structures Protection of timber Repaired timber structures Rapidly assembled and transferable timber structures Guidelines codes and regulations Structural failures Art and craftsmanship

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